CLAIMS

We claim:

1. A method for initiating communication between a first modem and a second modem, the method comprising, in combination:

applying at a first modem a ~~predefined~~ predetermined algorithm to dynamically generate a sequence of samples representing an analog answer tone signal;

encoding at the first modem the samples of the sequence, to generate a sequence of codewords; and

providing the sequence of codewords for transmission to the second modem, whereby, the second modem may receive the codewords of the sequence and interpret the sequence of codewords to represent an analog answer tone signal.

2. The method of claim 1, wherein the analog answer tone signal comprises a sinusoid of frequency 2100 Hz ± up to 15 Hz.

3. The method of claim 1, wherein applying the predetermined algorithm to dynamically generate a sequence of samples comprises generating *m* samples, each as a function X(*k*), where *k* extends from *n* to *m*+*n*-1.

4. The method of claim 3, wherein computing the function of X(*k*) comprises computing a periodic function of *k*.

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5. The method of claim 3, wherein the function X(k) comprises $\cos(2\pi k \times B/A + \theta)$.

6. The method of claim 5, wherein B/A is 79/301.

7. The method of claim 5, wherein θ is $0.25 \times \pi/301$.

8. The method of claim 3, wherein the function X(k) comprises computing $Y = S \times \cos(2\pi k \times B/A + \theta)$.

9. The method of claim 8, wherein S is $1000 \times \sqrt{2}$.

10. The method of claim 8, wherein computing the function X(k) further comprises rounding Y.

11. The method of claim 10, wherein rounding Y comprises rounding down Y.

12. The method of claim 10, wherein encoding the samples comprises PCM encoding Y.

13. The method of claim 1, wherein applying the predetermined algorithm to dynamically generate a sequence of samples comprises (i) applying the predetermined algorithm

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to generate a first subsequence of samples, (ii) applying the predetermined algorithm to generate a second subsequence of samples different than the first subsequence, and (iii) combining the first subsequence and the second subsequence,

whereby the sequence of codewords comprises a corresponding first set of codewords and a corresponding second subsequence of codewords different than the first set of codewords.

14. In a method for initiating communication between a first modem and a second modem comprising performing a digital impairment learning process in which N codewords are transmitted from the first modem to the second modem and the second modem analyzes the number of codewords to determine line characteristics, the improvement comprising:

(a) performing the method of claim 1; and

(b) thereafter, in the digital impairment learning process, transmitting to the second modem P codewords, wherein P is less than N.

15. The improvement of claim 14, wherein the P codewords exclude the codewords of the sequence of codewords provided in step (a).

16. A method for starting communication between a first modem and a second modem, the method comprising, in combination:

receiving at the second modem a sequence of codewords from the first modem, wherein the second modem recognizes the sequence of codewords as an encoded analog answer tone signal; and

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using the received sequence of codewords to determine whether to perform a shortened training sequence, by a process comprising:

(A) decoding each received codeword to produce a corresponding received sample;

(B) for each received sample, (i) applying a predetermined algorithm to dynamically generate a corresponding expected sample, (ii) comparing the expected sample to the received sample, and (iii) computing an error between the expected sample and the received sample;

(C) computing an overall error value using the computed error value between the expected samples and the received samples; and

(D) if the overall error value is less than a predetermined threshold value, deciding to perform the shortened training sequence, whereby the shortened training sequence may then be performed.

17. The method of claim 16, wherein the analog answer tone signal comprises a sinusoid of frequency 2100 Hz ± up to 15 Hz.

18. The method of claim 16, wherein the predetermined threshold value comprises an error value determined based on a previous connection.

19. The method of claim 16, wherein applying the predetermined algorithm to dynamically generate the corresponding expected sample comprises:

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using the predetermined algorithm employed to generate m samples, each as a function $X(k)$, where k extends from n to $m+n-1$.

20. The method of claim 19, wherein computing the function $X(k)$ comprises computing a periodic function of k.

21. The method of claim 19, wherein the function $X(k)$ comprises $\cos(2\pi k \times B/A + \theta)$.

22. The method of claim 21, wherein θ is $0.25 \times \pi/301$.

23. The method of claim 21, wherein B/A is 79/301.

24. The method of claim 19, wherein computing the function $X(k)$ comprises computing $Y = S \times \cos(2\pi k \times 79/301 + \theta)$.

25. The method of claim 24, wherein S is $1000 \times \sqrt{2}$.

26. The method of claim 24, wherein computing the function $X(k)$ further comprises rounding Y.

27. The method of claim 26, wherein the rounding Y comprises rounding down Y.

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28. In a method for initiating communication between a first modem and a second modem comprising performing a digital impairment learning process in which N codewords from the first modem are received by the second modem and the second modem analyzes the number of codewords to determine line characteristics, the improvement comprising:

(a) performing the method of claim 15; and

(b) thereafter, in the digital impairment learning process, the second modem receiving and analyzing P of codewords, wherein P is less than N.

29. The improvement of claim 28, wherein the P codewords exclude the codewords of the sequence of codewords received in step (a).

30. A network device employing a training sequence to start communication, the network device comprising, in combination:

a processor;

a data storage medium;

a first set of machine language instructions stored in the data storage medium and executable by the processor to dynamically generate a first set of codewords representing an analog answer tone signal;

a line interface unit for transmitting the first set of codewords onto a transmission line and for receiving from the transmission line a second set of codewords;

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a second set of machine language instructions stored in the data storage medium and executable by the processor for using the second set of codewords to determine whether to employ a shortened training sequence.

31. The system of claim 30, wherein the network device comprises a modem.

32. The system of claim 30, wherein the analog answer tone signal comprises a sinusoid of frequency 2100 Hz ± up to 15 Hz.

33. The system of claim 30, wherein the first set of instructions defines a predetermined algorithm for generating the first set of codewords.

34. The system of claim 33, wherein the predetermined algorithm comprises $X_k = Round\left\{1000 \times \sqrt{2} \times \cos\left(2\pi k \times 79/301 + 0.25 \times \pi/301\right)\right\}$.

35. The system of claim 30, wherein dynamically generating the first set of codewords comprises:

generating *m* samples using a predetermined algorithm comprising $X_k = Round\left\{1000 \times \sqrt{2} \times \cos\left(2\pi k \times 79/301 + 0.25 \times \pi/301\right)\right\}$, wherein k extends from n to m+n-1; and

encoding the *m* samples.

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36. The system of claim 30, wherein the second set of codewords represents the answer tone signal.

37. The system of claim 30, wherein the processor uses each codeword of the second set of codewords to determine whether to employ the shortened training sequence.

38. The system of claim 37, wherein for each codeword of the second set of codewords, the processor (i) decodes each codeword, (ii) generates a respective sample associated with each codeword, (iii) compares each decoded codeword to the respectively generated sample, (iv) computes an overall error value between the decoded codewords and the respectively generated samples, and if the overall error value is lower than a predetermined threshold value, (v) employs the shortened training sequence.

39. The system of claim 30, wherein the data storage medium stores a sequence of samples to dynamically generate the first set of codewords.

40. The system of claim 30, wherein the network device communicates with an entity arranged to dynamically generate the first set of codewords and provide the first set of codewords to the network device.

41. The system of claim 30, wherein the network device communicates with an entity arranged to dynamically generate and provide to the network device respective sample values and codewords associated with the second set of codewords.

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42. The system of claim 41, wherein the entity employs a predetermined algorithm comprising $X_k = Round\{1000 \times \sqrt{2} \times \cos(2\pi k \times 79/301 + 0.25 \times \pi/301)\}$ to generate the respective sample values and codewords.

43. The system of claim 41, wherein the network device uses the sample values and codewords generated by the entity to determine whether to employ the shortened training sequence.

44. A method for initiating communication between a plurality of modems, the method comprising, in combination:

applying at a first modem a ~~predefined~~ predetermined algorithm to dynamically generate a sequence of samples representing an answer tone signal;

encoding at the first modem the samples of the sequence to generate a sequence of codewords;

sending from the first modem the sequence of codewords to a second modem;

receiving at the second modem the sequence of codewords from the first modem, wherein the second modem recognizes the sequence of codewords as an encoded analog answer tone signal; and

at the second modem, using the received sequence of codewords to determine whether to apply a shortened training sequence.

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45. The method of claim 44, wherein the analog answer tone signal comprises a sinusoid of frequency 2100 Hz ± up to 15 Hz.

46. The method of claim 44, wherein the predetermined algorithm comprises

$$X_k = Round\left\{1000 \times \sqrt{2} \times \cos\left(2\pi k \times 79/301 + 0.25 \times \pi / 301\right)\right\}$$

47. The method of claim 42, further comprising

at the second modem, decoding each received codeword to produce a corresponding received sample; and

for each received sample, (i) applying the predetermined algorithm to dynamically generate a corresponding expected sample, (ii) comparing the expected sample to the received sample, (iii) computing an error value between the expected sample and the received sample, when all codewords are received, (iv) computing an overall error value using the computed error values for each received sample, and , if the overall error value is less than a predetermined threshold value, (v) applying the shortened training sequence.

48. The method of claim 47, wherein the predetermined threshold value comprises an error value determined based on a previous connection.

49. A method for initiating communication between a first modem and a second modem, the method comprising:

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applying a first predetermined algorithm to dynamically generate a sequence of samples representing an analog answer tone signal;

encoding the samples of the sequence to generate a sequence of codewords; and

providing the sequence of codewords for transmission to the second modem, whereby, the second modem may receive the codewords of the sequence and interpret the sequence of codewords to represent an analog answer tone signal.

50. The method of claim 49, wherein the analog answer tone signal comprises a sinusoid of frequency 2100 Hz ± up to 15 Hz.

51. The method of claim 49, wherein the first predetermined algorithm comprises $X_k = Round\{1000 \times \sqrt{2} \times \cos(2\pi k \times 79/301 + 0.25 \times \pi/301)\}$.

52. The method of claim 49, wherein an entity in communication with the first modem (i) applies the first predetermined algorithm to dynamically generate the sequence of samples, (ii) encodes the samples of the sequence to generate a sequence of codewords, and (iii) provides the sequence of codewords to the first modem.

53. The method of claim 52, further comprising storing on the first modem the sequence of codewords.

54. The method of claim 49, wherein an entity in communication with the first modem applies the predetermined algorithm to generate the sequence of samples and provides the samples of the sequence to the first modem.

55. The method of claim 54, further comprising storing on the first modem the sequence of samples and encoding the samples of the sequence to generate the sequence of codewords.

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